

NASA/TM-2009-215909
NESC-RP-08-19/08-00454



NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation

*David M. Schuster/NESC
Langley Research Center, Hampton, Virginia*

August 2009

NASA STI Program . . . in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA scientific and technical information (STI) program plays a key part in helping NASA maintain this important role.

The NASA STI program operates under the auspices of the Agency Chief Information Officer. It collects, organizes, provides for archiving, and disseminates NASA's STI. The NASA STI program provides access to the NASA Aeronautics and Space Database and its public interface, the NASA Technical Report Server, thus providing one of the largest collections of aeronautical and space science STI in the world. Results are published in both non-NASA channels and by NASA in the NASA STI Report Series, which includes the following report types:

- **TECHNICAL PUBLICATION.** Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA counterpart of peer-reviewed formal professional papers, but having less stringent limitations on manuscript length and extent of graphic presentations.
 - **TECHNICAL MEMORANDUM.** Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.
 - **CONTRACTOR REPORT.** Scientific and technical findings by NASA-sponsored contractors and grantees.
 - **CONFERENCE PUBLICATION.** Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or co-sponsored by NASA.
 - **SPECIAL PUBLICATION.** Scientific, technical, or historical information from NASA programs, projects, and missions, often concerned with subjects having substantial public interest.
 - **TECHNICAL TRANSLATION.** English-language translations of foreign scientific and technical material pertinent to NASA's mission.
- Specialized services also include creating custom thesauri, building customized databases, and organizing and publishing research results.
- For more information about the NASA STI program, see the following:
- Access the NASA STI program home page at <http://www.sti.nasa.gov>
 - E-mail your question via the Internet to help@sti.nasa.gov
 - Fax your question to the NASA STI Help Desk at 443-757-5803
 - Phone the NASA STI Help Desk at 443-757-5802
 - Write to:
NASA STI Help Desk
NASA Center for AeroSpace Information
7115 Standard Drive
Hanover, MD 21076-1320

NASA/TM-2009-215909
NESC-RP-08-19/08-00454



NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation

*David M. Schuster/NESC
Langley Research Center, Hampton, Virginia*

National Aeronautics and
Space Administration


Langley Research Center
Hampton, Virginia 23681-2199

August 2009

The use of trademarks or names of manufacturers in the report is for accurate reporting and does not constitute an official endorsement, either expressed or implied, of such products or manufacturers by the National Aeronautics and Space Administration.


Available from:

NASA Center for AeroSpace Information
7115 Standard Drive
Hanover, MD 21076-1320
443-757-5802

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: i

NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation

February 21, 2008

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: ii

Report Approval and Revision History

Approved: _____	Original signature on file _____	2/25/08
	NESC Director	Date

Revision	Description of Revision	Author	Effective Date
1.0	Initial Release	NASA Technical Fellow for Aerosciences	2/21/08



	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: iii

Table of Contents

Volume I: Technical Assessment Report	1
1.0 Notification and Authorization	1
2.0 Signature Page	2
3.0 Team List	3
4.0 Executive Summary	3
5.0 Problem Description, Proposed Solutions, and Risk Assessment	3
6.0 Findings, Observations, and Recommendations.....	10
7.0 Acronyms List.....	11
8.0 References	12

List of Figures


Figure 5.0-1. Proposed Ares I-X DFI reductions include aeroacoustic measurements.....	6
Figure 5.0-2. Ares I-X vehicle exhibits alternating pressure field similar to F/A-18E/F Abrupt Wing Stall	7
Figure 5.0-3. Unsteady, separated flow prediction is the top NASA Aerosciences challenge, 2007 Aerosciences State-of-the-Discipline presentation	8

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 1 of 12

Volume I: Technical Assessment Report


1.0 Notification and Authorization

NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation, presented to the NESC Review Board (NRB) on February 21, 2008. Dr. David Schuster, NESC Technical Fellow for Aerosciences is the responsible Lead for this assessment to be approved out-of-board by the NESC Director Ralph Roe.

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 2 of 12

2.0 Signature Page

Dr. David M. Schuster Date
Technical Fellow for Aerosciences
NASA Engineering and Safety Center
NASA Langley Research Center

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 3 of 12

3.0 Team List

Name	Discipline	Organization/Location
Core Team		
Dr. David Schuster	NESC Technical Fellow for Aerosciences	LaRC
Diana Kerns	MTSO Analyst	LaRC
Program/Project/Organization Liaisons		
Administrative Support Personnel		
Eric Pope	Technical Writer	LaRC/ATK


4.0 Executive Summary

This position paper is written as a result of a number of emails and a presentation that have recently been circulated concerning the potential reduction of Development Flight Instrumentation (DFI) to be included on the Ares I-X flight test vehicle. A reduction in instrumentation has been proposed presumably to reduce project costs and relieve project schedule pressures. This proposal has generated a significant amount of discussion on both sides of the issue, primarily from those within the project. The intention here is to provide a perspective on this issue from outside the mainline project.

5.0 Problem Description, Proposed Solutions, and Risk Assessment

In response to the proposed reduction in Ares I-X DFI, the project technical community has come down strongly on the side of maintaining the DFI on the vehicle, citing any number of arguments as to the value of these data to the Ares Project. They have participated in the definition and specification of the instrumentation. However, what appears to be strikingly missing from the Ares and Constellation technical community is a comprehensive plan to evaluate and utilize these data to the benefit of the Ares Project, the Constellation Program, and the Agency as a whole. This is not a unique issue to the Ares project alone, but has also been noted in other facets of the Constellation Program.

For the past two years, the NASA Engineering and Safety Center (NESC) have provided a Peer Review of the CEV Aerosciences Project (CAP) with the most recent review occurring in September 2007. Listed in [Section 6.0](#) are two findings from this most recent peer review relating to planned flight tests and utilization of resulting flight test data.


	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 4 of 12

These recommendations translate directly to the Ares Project and the utilization of planned Ares I-X DFI. Like Orion's CAP Team, the Ares Aerodynamics Panel is expending considerable effort to develop an aerodynamic database for the Ares I-X flight. The Ares I-X flight, and in particular the DFI, will be invaluable in helping this panel document and evaluate their methods and techniques as well as to further quantify their data uncertainty. It is imperative that the Aerodynamics Panel avoid generalization when discussing the disposition of the DFI, and focus instead on the specific approaches to using these data to verify their databases, quantify uncertainties, mitigate risk, and validate their approach to the development of the present and future Ares aerodynamic databases. This issue is deeper than simply validating the models used to make performance and environment predictions. It addresses the validation of the complete Aerosciences process used to design and predict performance on this vehicle, the mainline Ares vehicle, Orion, and following configurations within the Constellation Program

Like Orion's Pad Abort 1 (PA-1) test, significant discussion has surrounded the selection of the 605-series Launch Abort geometry for the Ares I-X flight test as opposed to adopting the more recent ALAS geometry. Some have speculated that political pressure to perform the PA-1 and Ares I-X flight tests as early as possible in the program has driven this decision, and in doing so, has severely degraded the technical value of the flight tests. The fact of the matter is that, independent of the specific geometry flown; these flights provide a first-look for engineers responsible for developing their flight databases to quantitatively evaluate their methods and techniques. However, if the instrumentation included on these flights is minimized to the point where only general flight characteristics of the vehicle are obtained, the value of testing a geometry known to be obsolete begins to come into increasing question. Detailed flight test data is very rare and the value of these data cannot be overemphasized.


The NESC is currently conducting three assessments involving the aeroacoustic and unsteady flow environments of launch vehicles. One of these is supporting Ares aeroacoustic predictions and measurements and another is looking at the aeroacoustic environment predictions for the Constellation Program as a whole. The aeroacoustic environments for the Ares and Orion vehicles have been a pacing item for the vehicle's development. The projects have been forced to primarily use empirical methods based on unsteady pressure test data acquired in the 1960's. The projects are also conducting extensive wind tunnel testing to characterize the unsteady pressure and aeroacoustic environments on their vehicle concepts. The aeroacoustic environments on the Orion and Ares vehicles are severe enough to motivate the program to make a significant change to the vehicle Outer Mold Line (OML), adopting the so-called ALAS geometry over the more Apollo-like 605-series Launch Abort Vehicle (LAV) geometry.

The Ares/Orion concept operates at flight conditions that are more severe than the Apollo system with the vehicle reaching transonic and maximum dynamic pressure conditions at a lower altitude than Apollo, which results in higher dynamic pressure and aeroacoustic environments. So the Ares/Orion flight conditions are outside the Apollo empirical test and flight database,

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 5 of 12

raising the uncertainty in the Constellation program predictions. The DFI included on the Ares I-X flight test article includes an extensive suite of unsteady pressure and aeroacoustic measurements that would provide significant insight into the aeroacoustic environment on the vehicle. Despite the fact that the Ares-I-X is flying an outdated Orion OML, the Ares and Orion projects must predict the flight environments for this vehicle and resulting flight data would provide rare and much-coveted flight data that engineers would use to validate predictions and identify weaknesses in their prediction methodology.

As depicted on slide 17 of the Reference 1 Ares I-X presentation, Figure 5.0-1, unsteady pressure and aeroacoustic data on the vehicle are among the instruments considered for “significant reductions.” Beyond the aforementioned value of these flight data to reduce the uncertainty on aeroacoustic environments and validate the methods and techniques used to predict these environments, recent wind tunnel test data acquired on the Ares I-X geometry indicate the potential for additional transonic unsteady aerodynamic issues that have not been predicted in previous analyses. Figure 5.0-2 presents unsteady pressure measurements acquired in a recent buffet test conducted in the NASA Langley Transonic Dynamics Tunnel (TDT) on an Ares I-X model. This test measured an alternating unsteady pressure just behind the large-angle transition from the conical Command Module to the cylindrical Service Module. This pressure fluctuation isn’t a typical high-frequency periodic pressure oscillation as associated with most aeroacoustic environments. It is a low-frequency square-wave oscillation that can result in large load shifts on the vehicle. A similar pressure oscillation was observed during testing of an F/A-18E model as part of the Abrupt Wing Stall (AWS) investigation. This investigation demonstrated that AWS was a likely cause for the wing drop phenomenon that was encountered on the F/A-18E/F. Wing drop was not predicted prior to flight testing of the aircraft and discovery of this flight issue so late in the program was nearly catastrophic to the project. This alternating fluctuating pressure phenomenon was observed at Mach 0.90 on both the Ares I-X and the F/A-18E/F; directly in the heart of the transonic flight regime. The alternating pressure field observed on the F/A-18E/F was at a sufficiently low enough frequency that the automatic flight control system on the aircraft could not effectively compensate for the wing drop. Given the highly slender Ares I-X vehicle and the forward location of this observed alternating flow, a similar impact on flight control of the launch vehicle could be encountered. The high degree of bending flexibility on the Ares vehicle further complicates this issue.

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 6 of 12



DFI Used for Secondary Objectives




Objective	Measurement	Sensor
S1: Quantify the effectiveness of the First Stage separation motors	BDM Performance	BDM case strain sensors (8)
	1 st Stage Position, Velocity and Accelerations	1 st Stage INU
S2: Characterize induced environments and loads on the FTV during ascent flight phases	Aero Acoustic Measurements	60 Unsteady Pressures (2 KHz) 245 Unsteady Pressures (100 Hz)
	Thermal	100 Calorimeters 6 Radiometers 13 Gas Temperature Probes 70 Static and Differential Pressures 119 Temperatures
	Structural	4 Internal Microphones 88 Accelerometers (80 Hz) 17 Accelerometers (1000Hz) 106 Strain Gauges
S3: Demonstrate a procedure to determine the vehicle's pre-launch geodetic orientation vector for initialization of the flight control system	None	N/A
S5: Characterize induced loads on the LV on the launch pad	Structural	Same as for S2
S6: Assess potential Ares I access locations in the VAB and on the Pad	None	N/A
S7: Validate 1 st Stage electrical umbilical performance	None	N/A

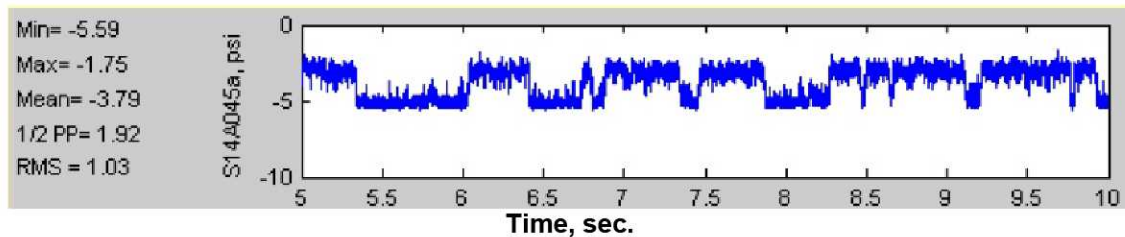
Significant Reductions Considered

National Aeronautics and Space Administration

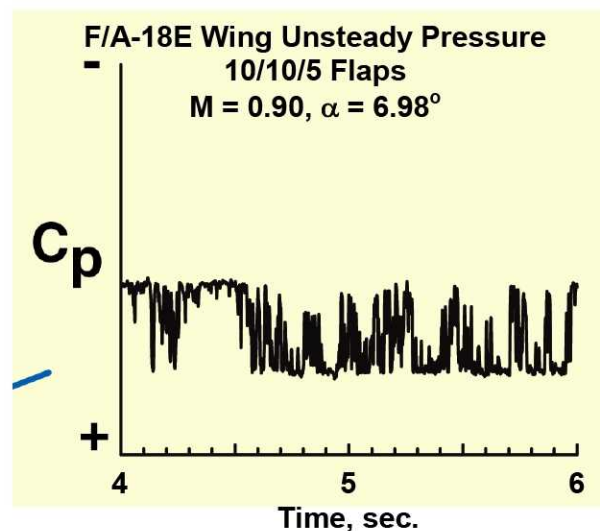
17

Figure 5.0-1. Proposed Ares I-X DFI reductions include aeroacoustic measurements.

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 7 of 12




a) Ares I-X alternating unsteady pressure field.



b) F/A-18E/F Alternating pressure field observed at Abrupt Wing Stall conditions.

Figure 5.0-2. Ares I-X vehicle exhibits alternating pressure field similar to F/A-18E/F Abrupt Wing Stall

Large control deviations in the transonic flight regime have been previously observed on launch vehicles. Most recently, the Delta II Heavy launch vehicle had to stand down operations due to large motor nozzle gimbaling deviations as the vehicle passed through transonic flight. Extensive computational analyses and wind tunnel testing ultimately resulted in the conclusion that alternating pressure fields similar to those discussed above were the cause for these gimbaling deviations and a solution to the problem was formulated. Only recently did the Delta II Heavy return to flight with the successful launch of the Dawn Mission in September 2007. Given that the Ares I-X vehicle has exhibited an unsteady pressure field similar to two vehicles, one a launch vehicle, that have experienced control anomalies in the transonic flight regime, the DFI included on the vehicle could be of significant value to the Ares Project and the Constellation Program should the flight vehicle experience a control upset as it transits transonic flight. The unsteady pressure measurements included in the DFI would verify whether this type

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 8 of 12

of alternating pressure field indeed exists on the vehicle and if so, its impact on the flight control system and stability.

A responsibility of the NASA Technical Fellows is to evaluate their respective disciplines and develop a state-of-the-discipline to be presented to the NASA Engineering Management Board. In 2007, the NASA Technical Fellow for Aerosciences presented a state-of-the-discipline to the EMB, Reference 2, which highlighted the top three aerosciences technical challenges facing NASA projects and programs. Heading this list is the prediction of unsteady, separated flows, Figure 5.0-3. Prediction of unsteady flow characteristics, particularly unsteady pressures, is a pacing item for estimation of aeroacoustic, buffet, and aeroelastic performance, and these issues are of extreme importance to the Ares, Orion, and other Constellation designs. They are also very important to projects in each of the NASA Missions, including Space Shuttle, Science, and Aeronautics projects. Acquisition of flight data to address these problems provides critical information for understanding the physics of these flows, parameters, and conditions under which they exist, and most importantly, data that allows the Agency to assess its ability to capture and predict these flows and vehicle responses to them. This is data that helps enable future designs from an Agency perspective, not just for Exploration Mission programs.



Top Aeroscience Challenges




Three aeroscience areas are currently hindering the prediction of environments and performance for flight vehicles. (In order of criticality)

- 1. Prediction, characterization and quantification of unsteady, separated flows**
 - Testing is very expensive and time-consuming
 - Acoustics and buffet loads estimation require accurate characterization of these flows.
- 2. Assessment of Aero-thermodynamic Environments.**
 - Spacecraft ascent/reentry, hypersonic air vehicles.
 - High-Mach boundary layer transition, ablative TPS performance.
- 3. Aero-propulsion interaction.**
 - Aero-plume interactions, reaction control systems, hypersonic air vehicle propulsion systems.

10


Figure 5.0-3. Unsteady, separated flow prediction is the top NASA Aerosciences challenge, 2007 Aerosciences State-of-the-Discipline presentation

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 9 of 12

The Aerosciences Technical Fellow maintains a Technical Discipline Team (TDT) consisting of nearly 30 aerospace experts from across the Agency, other government entities, industry, and academia. Members of this team have recently raised the issue of the acquisition of engineering flight data and the continual pressure to reduce or de-scope engineering instrumentation on flight manifests due to schedule and budget considerations. Like the DFI of the Ares I-X project, engineering data instrumentation is often relegated to a secondary or lower flight objective and when projects begin to encounter the inevitable budget and schedule pressures they are the first candidates for reductions or elimination. While the Aerosciences TDT recognizes the paramount importance of the primary mission of the vehicle, they also hold that most, if not all, NASA flights, including the Space Shuttle, are unique in some aspect. When a flight involves unique conditions beyond its primary mission, be it a new or extreme flight profile, an innovative vehicle design enabling the missions primary objective, or, in this case, a development flight test laying the groundwork for future vehicle designs, every effort should be made to acquire engineering data for these flights so that the full value of them can be realized by the Agency and the engineering community at large. The Aerosciences TDT has just begun discussion of this topic in depth, and additional formal position statements on this subject can be expected from this team.

In summary, four issues have been raised in relation to the proposed Ares I-X DFI reductions:

1. A contributor to the proposal to reduce DFI on the vehicle is likely a result of insufficient planning and documentation for using the data when and if it is acquired. A detailed plan for using the data to evaluate and validate the design and analysis methods used on the Ares, Orion, and Constellation vehicles would better illuminate the impact of eliminating this flight instrumentation.
2. Unsteady pressure measurements characterizing the buffet and aeroacoustic environments are a target of the proposed significant reductions. Aeroacoustic environments are a pacing item for the design of both the Ares and Orion vehicles and they have already prompted a significant design change to the Orion LAV OML. Validation of the methods used to predict the previously high aeroacoustic environments is of critical importance to the Constellation Program and its current and future designs.
3. Recent tests of the Ares I-X geometry indicate an alternating unsteady flowfield on the vehicle, which has been shown to potentially lead to significant control upsets on other aircraft and launch vehicle designs during transonic flight. Should similar control deviations be encountered on the Ares I-X in the transonic speed range, the DFI data will provide essential information as to the cause of this upset.
4. Prediction and characterization of unsteady separated flows has been found to be the top aerospace challenge influencing NASA's projects and programs. Much of the data included in the Ares I-X DFI suite directly addresses this issue and given the rarity of flight data would be invaluable in addressing this challenge.

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 10 of 12

In summary, the NASA Aerospace Technical Fellow and the Aerosciences Technical Discipline Team emphasize the importance of the Ares I-X DFI and recommend that careful attention is focused on the above four items before endorsing or accepting a proposal to reduce this instrumentation. While this paper is written from an aerospace perspective, it should be noted that similar arguments concerning other disciplines could also be formulated. The Ares IX DFI includes instruments to measure structural and thermal data that would be used to validate prediction and characterization processes for structures, structural dynamics, aeroelasticity, aerothermodynamics and other engineering disciplines that have direct impact on the design and performance of the vehicle. Flight tests of this magnitude are extremely rare and the engineering data they can provide could be as important to the Ares and Orion Projects and the Constellation Program as the operational demonstration of the flight test. Beyond the Constellation Program, these data have potential impact on a wide range of current and future NASA projects and would benefit the Agency and the engineering community at large.


6.0 Findings, Observations, and Recommendations

Note: The Findings and Recommendations listed below are excerpted from NESC Document No. RP-06-19_05_177_E, “Peer Review Feedback for the CEV Aerosciences Project (CAP)” resulting from the NESC CAP Peer Review #3 held 18-20 September 2007, and are included here for reference.

Finding: The potential of flight experiments (PA-1, LEX) and other experiments (CUBRC® blowing test, etc.) to mitigate risk are not effectively formulated and transmitted to the Program.

Discussion: *The Orion Project is preparing to perform several flight tests for which the CAP has responsibility to deliver aerodynamic and aerothermodynamic databases. Flight test and other detailed test data against which to compare predictions is rare and extremely valuable in helping to ground the database predictions. The Peer Review team feels that leveraging these tests to verify and validate the aerodynamic and aerothermal databases is a logical risk mitigation strategy for the CAP team. The CAP team has also expressed interest in acquiring additional flight data on PA-1 to help validate their jet interaction predictions and better understand the jet interaction issues on the Launch Abort Vehicle (LAV). During the review, the team expressed concern as to whether they would be given the extra gauges on the PA-1 test to evaluate the jet interaction issue. The Peer Review team feels that by specifically casting the flight tests and other high-level testing as risk mitigation for the database construction that they will be better able to advocate for additional instrumentation and measurements on these tests.*

Recommendation (R-47): Flight testing such as PA-1 and LEX and other high-level tests such as the CUBRC Ablator Blowing Test should be included in the overall risk mitigation strategy

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 11 of 12

for the database construction. Also, clearly communicate this risk mitigation option to the Orion Project.”

and


Finding: The CAP team has no plan or schedule to analyze, evaluate, and compare PA-1 flight data with the supplied aerodynamic database.

***Discussion:** The PA-1 flight test is a unique opportunity to compare full-scale flight data with predicted flight characteristics. The vehicle’s overall performance as well as some of the detailed performance of its systems, such as the Abort Motor and Active Control Motor, will be measured during the flight and will be invaluable to the evaluation of the CAP team’s ability to predict the performance of this type of flight vehicle. The CAP team has no formal plan or schedule in place to analyze the flight data and compare it against their database predictions. The NESC Peer Review team feels this is an essential component to the overall development of the Orion Aerosciences database. Despite the fact that the PA-1 geometry is significantly different than the present baseline geometry, many of the flow phenomena and interactions will be similar or the same as those found on the baseline vehicle. Differences and similarities between the PA-1 flight data and predicted performance will also provide invaluable insight into the team’s tools, strategies, and processes.*

Recommendation (R-51): A plan and schedule should be developed to analyze and compare PA-1 flight data with aerodynamic and aerothermodynamic database predictions. The plan should be developed to evaluate the team’s tools, strategy, and processes as well as their ability to predict specific flight parameter values and the suitability of uncertainty values associated with these data.”

7.0 Acronyms List

ALAS	Alternate Launch Abort System
AWS	Abrupt Wing Stall
CAP	CEV Aerosciences Project
CEV	Crew Exploration Vehicle
DFI	Development Flight Instrumentation
EMB	Engineering Management Board
LaRC	Langley Research Center
LAV	Launch Abort Vehicle
LEX	Lunar rEntry eXperiment
NASA	National Aeronautics and Space Administration
NESC	NASA Engineering and Safety Center
NRB	NESC Review Board

	NASA Engineering and Safety Center Technical Report	Document #: RP-08-19	Version: 1.0
Title: NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation			Page #: 12 of 12

OML	Outer Mold Line
PA-1	Pad Abort 1
TDT	Transonic Dynamics Tunnel
TDT	Technical Discipline Team
TPS	Thermal Protection System

8.0 References

1. "Potential Reduction of Ares I-X DFI Measurements," PowerPoint presentation to the Ares I- Ares I-X Measurement Interface Meeting, 13 February 2008.
2. Schuster, David M., "State of the NASA Aerosciences Discipline," PowerPoint presentation to the NASA Engineering Management Board, 26 September 2007.

REPORT DOCUMENTATION PAGE					Form Approved OMB No. 0704-0188	
<p>The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.</p> <p>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</p>						
1. REPORT DATE (DD-MM-YYYY)		2. REPORT TYPE		3. DATES COVERED (From - To)		
01-08-2009		Technical Memorandum		February 2008		
4. TITLE AND SUBTITLE NASA Aerosciences Perspective on Proposed De-Scope of Ares I-X Development Flight Instrumentation				5a. CONTRACT NUMBER		
				5b. GRANT NUMBER		
				5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Schuster, David M.				5d. PROJECT NUMBER		
				5e. TASK NUMBER		
				5f. WORK UNIT NUMBER 869021.01.07.01.01		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) NASA Langley Research Center Hampton, VA 23681-2199				8. PERFORMING ORGANIZATION REPORT NUMBER L-19744 NESC-RP-08-19/08-00454		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Aeronautics and Space Administration Washington, DC 20546-0001				10. SPONSOR/MONITOR'S ACRONYM(S) NASA		
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) NASA/TM-2009-215909		
12. DISTRIBUTION/AVAILABILITY STATEMENT Unclassified - Unlimited Subject Category 19-Spacecraft Instrumentation and Astrionics Availability: NASA CASI (443) 757-5802						
13. SUPPLEMENTARY NOTES						
14. ABSTRACT This position paper is written as a result of a number of emails and a presentation that have recently been circulated concerning the potential reduction of Development Flight Instrumentation (DFI) to be included on the Ares I-X flight test vehicle. A reduction in instrumentation has been proposed presumably to reduce project costs and relieve project schedule pressures. This proposal has generated a significant amount of discussion on both sides of the issue, primarily from those within the project. The intention here is to provide a perspective on this issue from outside the mainline project.						
15. SUBJECT TERMS Ares I-X; Crew Exploration Vehicle; Development Flight Instrumentation; NASA Engineering and Safety Center						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON	
a. REPORT	b. ABSTRACT	c. THIS PAGE			STI Help Desk (email: help@sti.nasa.gov)	
U	U	U	UU	20	19b. TELEPHONE NUMBER (Include area code) (443) 757-5802	